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REPORT ON FRENCH SPACE RESEARCH

[Following is a translation of extracts of a report on CNES (Centre National d'Etudes Spatiales; National Space Research Center) of France, pages 9-12, 39-41, 44-46, 109-110.]

I-1. The present report covers the period from 1 September 1962 to 1 September 1963, hereinafter called year 1963. This is a continuation of a first activity report presented to Parliament at the end of 1962, which dealt with the first six months of CNES.

These first months had been used to define a space policy and to set up the scientific, technical and administrative bodies necessary to carry out this policy.

The year 1963 as a whole demonstrated the solidity of the bases established in 1962. CNES was able to develop rapidly and to carry out the very tight program set for it by the Government. Important factors of this success were the support of the State Minister responsible for Scientific Research and Atomic and Space Problems and of the many organizations under his authority (Delegation Generale a la Recherche Scientifique et Technique [General Delegation for Scientific and Technical Research] and Commissariat a l'Energie Atomique [Atomic Energy Commission]), the understanding of the Ministry of Finance, and a constructive collaboration with the other ministries (Foreign Affairs, Armed Forces, Postal and Telecommunications, and National Education).

I-2. The first report of activity had indicated two fields of action for French policy:

-- A national program including construction of a French satellite to be placed in orbit by a French launcher;

-- Active participation in European organizations.

Activity during 1963 was oriented in these two directions.

I-2.1. The scientific and technical program of CNES has been governed by the following principles:

a) To make the scientific and technological base of the space experiments as broad as possible:

-- At the scientific level, CNES has not sought to create within itself a powerful and strong hierarchy. It has desired to support or favor the formation of strong outside teams around dynamic individuals, so as to favor the profusion of ideas produced naturally in a free environment.

-- At the technological level, since industrial support of space research is rather weak at present, it was important to develop it as quickly as possible. To this end, CNES, in collaboration with the other ministries, has set up a program of technical research. In addition, it has endeavored to create a healthy emulation among various manufacturers by systematically organizing competition through invitations to bid, with selection based primarily on the technical quality of the offerings.

b) To bring the greatest possible prudence into ballistic operations. CNES has systematically used tested sounding rockets, such as Veronique, Belier and Centaure. The 1962-1963 firings demonstrated their capability of carrying the equipment necessary for complex experiments. Fifty rockets were fired in 1963. Thanks to their high quality, CNES experienced no propulsion failures. They are of old design, however, and it is urgent that a new and more elaborate power generation system be developed; hence the tests of Dragon and the decision to build a new liquid-propellant rocket derived from Veronique.

With all this, the French groups are not yet assured of being able to carry out an intricate test with much chance of success, since our technical equipment has not yet as a whole reached space norms. The most serious deficiencies have appeared in the area of on-board equipment and not at the level of the test experiments themselves, which are generally of high intellectual quality, witness the adoption by NASA of certain French space programs.

As for the satellite launcher, CNES cannot at the present time adopt any other than the Diamant which, it is reasonable to expect, will have its first firing in 1965. However, the future possible applications of space research, technical as well as scientific, depend on the available electric power on board the vehicles. The dimensions and weight of the first series of Diamant satellites are adapted to a maximum power of 4 watts, which will rather severely limit the possible programs. The tracking and telemetering stations necessary for the Diamant program are in process of realization. It is planned to install them in Africa.

c) To promote space technology. The orbiting of satellites, reserved for CNES by law, is still in an embryonic state in France. It is impossible for France to undertake ambitious plans as long as the indispensable technical and industrial base has not been established. This will take several years, even if the necessary continuity of views can be maintained.

Only close contact with American specialists could enable us to make up the lag and acquire the essential techniques. This is why CNES has devoted a large part of its efforts to sending young engineers for lengthy periods to American laboratories. It is proud to have succeeded by this means in forming a competent team to make up the "Satellite" Division of its Direction Scientifique et Technique (Scientific and Technical Board). This team will act as a catalyzer for the training of technicians in industry and in Universities. Its influence is growing daily. It is unquestionably behind a real improvement in the standard of performance by the manufacturers with whom CNES deals. Project FR 1 (France 1), a French satellite to be orbited by an American booster and subject of an agreement concluded in 1961 between NASA and the Comite des Recherches Spatiales (Space Research Committee), is on the road to realization.

I-2.2. The normal functioning of the two European organizations (CECLES -- European organization for the perfection and construction of space craft boosters, and CERS -- European organization for space research) has been hampered by non-ratification of the treaties signed in the spring of 1962. Up to the present, three states out of seven have ratified CECLES and three out of ten have ratified CERS. France has ratified neither of the two conventions. It is essential that she do this before the end of 1963. In fact, a certain number of countries are awaiting the French decision before taking a stand of their own.

Despite these difficulties, the year 1963 is far from having been lost. International teams have been recruited and formed, whose members have learned to work together. Administrative structures have been set up and regulations adopted. CERS has initiated research on satellites. The CECLES program has developed normally, each state on its own responsibility having done the part assigned to it. It is reasonable to expect the first complete launcher blast-off in 1966.

The French delegation has effectively participated in these labors. Formed of a small number of representatives from the Ministry of Foreign Affairs and from CNES working in close collaboration, it has presented clear and harmonized points of view, which as a whole have been taken into consideration.

I-3. The year 1963 has seen the geographic deployment of CNES. In terms of the aero-space suitability of Southwest France and of the decisions of the Inter-Ministerial Committee of 31 July 1963, the establishment and scope of CNES installations have been fixed as follows:

Paris -- headquarters;

Bretigny-sur-Orge -- Scientific and Technical Board;
-- a limited Technical Center available to the teams of scientists of the University and of National Center for Scientific Research in the Paris region;

Toulouse -- the main Technical Center, relying on local teams of scientists; its development will be encouraged by the Ministry of National Education and CNES and should be activated in 1967;

Marseilles -- a team of astro-physicists, formed and developed within the University and in collaboration with observatories in the Mediterranean area;

Aire-sur-Adour -- A Balloon Launching Center, to answer French and European needs, in the process of installation.

The installations at Bretigny-sur-Orge have been rapidly completed, thanks to the use of pre-fabricated structures. At the present time, the offices and laboratories of the Scientific and Technical Board permit the normal functioning of on-site teams. Construction in the area authorized by the Inter-Ministerial Committee has begun and will be completed in 1964 and within the time limits compatible with the program.

[Pages 13-38 of the report are missing. Translation resumes with the first complete sentence on page 39.]

... Because of its proximity to heavy maritime traffic, the Ile du Levant base imposes conditions requiring the use of perfectly operating equipment.

III-2.4. During this year's runs, it appeared that some of the failures originated from the increasing complexity of the equipment placed in the nose cones. This is why CNES had to install a testing center for nose cones at Bretigny-sur-Orge (effect of vibrations, vacuum, checking the electronic system).

Henceforth, all rocket nose cones will be tested at Bretigny before being sent to the launching pads.

As a result of these tests, CNES anticipates a sizable increase in the number of successful firings.

III-2.5. During 1963, 12 Veronique, 3 Belier, 24 Centaure, 2 Dragon and 8 meteorological rockets were fired.

III-3. Satellites

The Satellites Division of the Scientific and Technical Board of CNES is currently working on the first three French satellites FR 1, FR 2, and FR 3.

Scientific satellite FR 1, built in France, will weigh 50 kg and its orbit will be almost circular at an altitude of about 800 km. The plane of the orbit will make an angle of 78° to the equator.

Satellites FR 2 and FR 3 are technological satellites intended for studying the satellite launcher Diamant and to test the behavior of components of French manufacture under space conditions. They include tests bearing on the study of the space medium.

Satellites FR 4, FR 5 and FR 6, whose programs have been defined in principle by the Scientific Commission, will not enter the construction phase until after the beginning of 1964.

The principal technical problems to be solved in building a satellite are:

-- study of structure;

-- stabilization and attitude control;

-- power supply;

-- thermal equilibrium;

-- electrical systems and their integration (telemetering, telecommunications).

In order to profit by the experience of the Americans and to avoid as many of their difficulties as possible, CNES has sent 12 engineers for a lengthy stay in the United States to study the problems of satellite construction. They form the nucleus of the team working on the construction of satellites FR 1, FR 2 and FR 3.

FR 1 -- In September 1963, construction of the satellite was ordered. The same was done for the electrical generators (solar cells and silver-cadmium storage batteries) to supply a mean power of 9 W. This will not be used in full at all times; 4 to 5 w will be used continuously on a commuted telemetering system of 50 circuits functioning on the 136-137 MHz frequency band and on a tele-command operating at 148 MHz. The signals from this telemetering system will send information on the proper functioning of the satellite, each parameter being checked at least once a second. This continuous telemetering system will also serve as a beacon to enable determina-

tion of the satellite's location.

From time to time, when the satellite passes over a telemetering receiving station, the tele-command will start operating the transmitter of the scientific telemetering system. This latter includes five wide band channels to correspond to the three magnetic and two electric antennas that equip the satellite.

During this period, electricity consumption may reach 20 w.

Satellite FR 1 will be stabilized by rotation (10 to 15 turns a minute). Its attitude will be logged by solar plotters and magnetometers.

The American Minitrack tracking and telemetering system will be used.

FR-2 and FR 3 -- These two first satellites to be put in orbit by the French launcher Diamant will be composed of two parts:

1) An equipment compartment, forming part of the third stage of the booster and intended for the study of the booster itself;

2) The satellite proper; which will study the space medium and behavior of the French equipment.

They will be launched from Colomb Bechar into an orbit whose altitude will vary between 600 and 3,000 km and make an angle of 30° to the equator. Accordingly they will frequently be in the region of space called "radiation belts" (natural and artificial belts).

The equipment compartment, already on order, will verify the placing of the last stage in rotation and the slowing down of the satellite's rotation. It will measure the separation speed and the modalities of opening the cap.

The satellite proper will primarily study the effects of particular radiation on the solar generators according to their sheathing. It will also include a measurement of the electronic and protonic radiations in terms of energy.

The principal difference between FR 2 and FR 3 arises from the fact that FR 2 can transmit only information obtained in direct line of sight of the telemetering stations. On the other hand, FR 3 will carry on board a magnetic recorder which will permit us to know the results of measurements made outside the covered regions.

[Pages 42-43 of the report are missing. Translation resumes with page 44.]

III-5. Advanced Programs

The Programs Division of the Scientific and Technical Board has undertaken a number of studies adapted to a more remote future. These studies may be placed in two main categories:

III-5.1. In the first are projects designed to ascertain whether certain types of satellites are feasible in terms of French conditions. These projects have been concerned especially with an eventual stabilized solar observatory, launched by the Diamant rocket. The first French satellites are not stabilized enough to permit solar observations. It had to be determined whether the weight of a more accurate stabilizer might not exceed the capacities of the first generation of satellite launchers.

Two stabilization systems have been considered.

In the first, the satellite is stabilized along the three axes, which permits very exact plotting (pointage). In the second case, it is stabilized in only one direction, that of the axis around which the satellite is turning. The satellite is thus stabilized gyroscopically. Obviously the axis must be oriented in the direction of the sun.

For a less developed stabilization, studies have also been made on the possibilities of stabilization by gravity gradient.

In addition, studies have been initiated relative to an eventual lunary mission (trajectory, required rocket thrust)

III-5.2. In the second category are advanced technological studies on equipment that will undoubtedly be of use in the relatively near future.

First there is an improved version of Veronique 61, a version guided more or less crudely to largely correct the deviations in trajectory due to the effect of the wind. The Veronique rocket has in fact the defect of being very sensitive to winds, and its point of contact after fall-back is often at some distance from the place of launching. Thus it can only be used under favorable weather conditions and on a launching area large enough for there to be no hazard at the time of fall-back.

III-5.3. Technical Studies of Solar Batteries of Silicon and of Cadmium Sulphur

These studies are designed to improve functioning conditions for French solar cells from the point of view of electrical yield and behavior under radiation.

In the field of electrical supply, studies have been undertaken on insulated nickel-cadmium storage batteries.

III-5.4. Study of a Prototype On-Board TV Camera (Vidicon Type)

A certain number of scientific test experiments require film shots of phenomena taking place inside the pay load. The use of photographic equipment would make it necessary for the pay load to be recovered. In the present state of French technology, such an eventuality can be considered only for sounding rockets or balloons. In the case of satellites, pictures must be transmitted by television. This is a rather difficult problem, since the camera must be light but solid enough to resist vibration, and its consumption of electrical energy should be small. In particular, a system of electrostatic deviation and scanning must be used.

III-5.5. Laser Telemetry

A light beam of one hundred millionth of a second may be directed to a satellite by laser. If the satellite reflects light toward the earth, where it is received by a photo-multiplier, measurement of the elapsed time may give the distance of the revolving satellite with an accuracy of about ten meters.

France plans to use such a device around the beginning of next year for tracking American satellite S 66, built especially for this test experiment, since it carries several reflectors on its surface.

III-5.6. Project of an On-Board Nuclear Reactor

The problem of a satellite's electrical supply is one of the most difficult.

The procedures presently used enable us to obtain only a few tens of watts. Many scientific test experiments require much more. Accordingly, at the request of CNES, the Atomic Energy Commission has embarked on a long-term study of an on-board nuclear reactor, an atomic battery which, placed in a satellite, would supply it with the necessary power. This power would be considerably greater (several kw) than that obtained by solar batteries.

[Pages 47-108 of the report are missing. Translation resumes with page 109.]

6. Protocol of Agreement between CNES and the Argentine National Commission for Space Research

The manifold benefits resulting from international collaboration in scientific activities and from coordination of efforts in the field of space research have led members of the Comision Nacional de Investigaciones Espaciales [National Commission for Space Research] of Argentina and of the Centre National d'Etudes Spatiales (CNES) to study together in Paris and in Buenos Aires the means of establishing a close collaboration between these two bodies.

Following these talks, the following aspects have been settled upon as

point of departure of a program of mutual collaboration:

1) Facilitate an exchange of physicists and technicians, who will thus have an opportunity of doing research and of performing experiments in the laboratories of the two countries. Special courses will also be organized.

2) Achieve a suitable exchange of scientific and technical data, including regular publications, technical reports, descriptions of experiments and all other information, written or not, on space research.

3) Study the different possibilities of common programs of research and experiments in the space field.

4) Facilitate the obtaining of devices, research instruments or technical components for training personnel or carrying out studies and experiments in both fields.

5) Consider every other possibility of increasing the benefits of international collaboration in the scientific field.

In order to materialize this program of collaboration while taking into account the objectives proposed by COSPAR at its Congress of May 1962 at Washington, it was agreed to carry out first of all a series of Centaure rocket launchings from the Chamical base, for the purpose of determining high altitude winds by the use of sodium.

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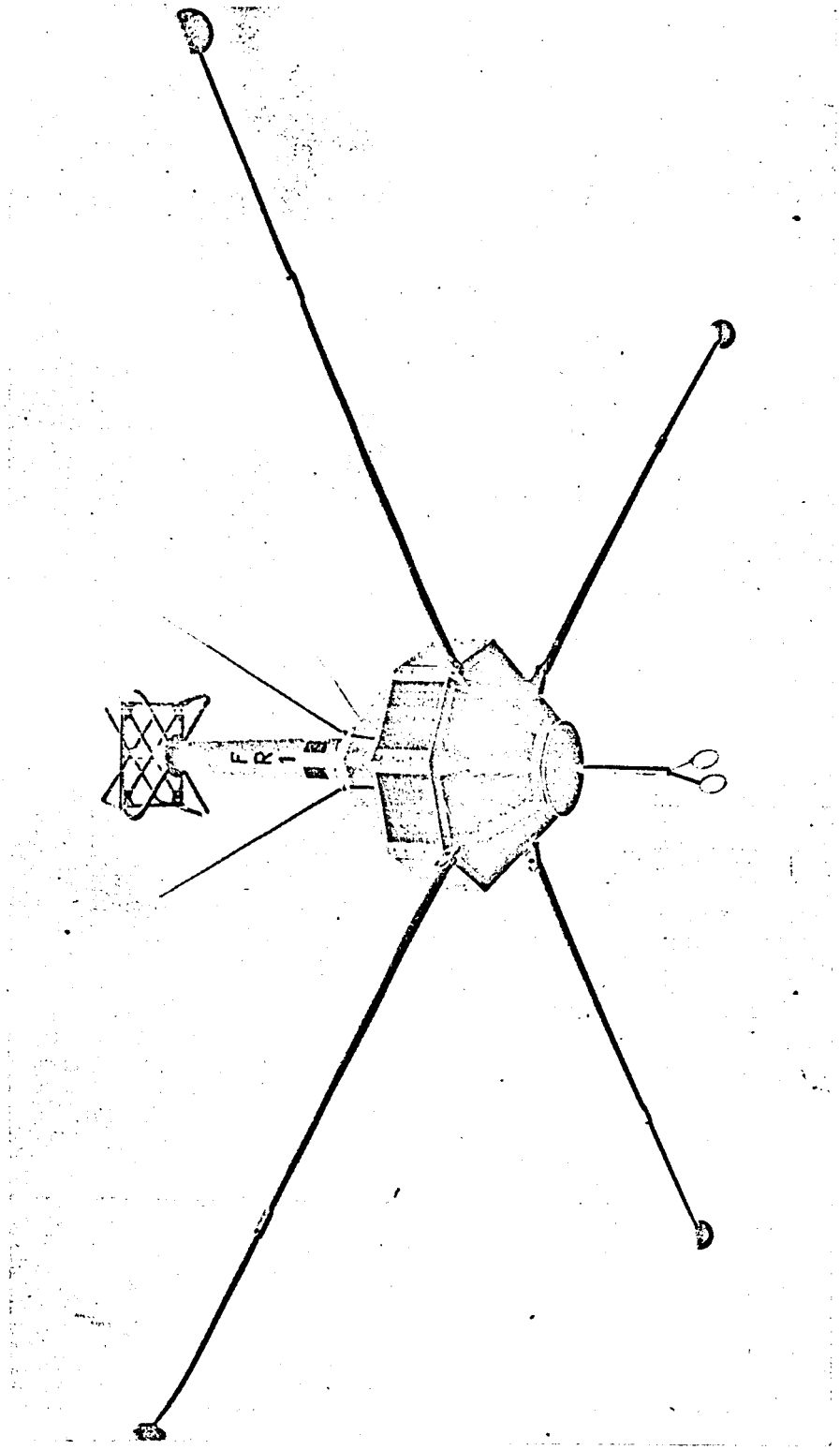

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